

C4. CHAPTER 4 PERSONNEL PROTECTION

C4.1. SCOPE AND APPLICATION

This chapter establishes blast, fragment, and thermal hazards protection principles. It applies to all operations and facilities within an Explosives Safety Quantity-Distance (ESQD) arc in which personnel are exposed to AE hazards. Army Technical Manual (TM)-5-1300/Naval Facilities Engineering Command (NAVFAC) P-397/Air Force Regulation (AFR) 88-22 (Reference (g)) contains design procedures to achieve personnel protection, protect facilities and equipment, and prevent propagation of explosions.

C4.2. RISK ASSESSMENT

The responsible DoD Component shall perform a risk assessment on new or modified operations and facilities involving AE. Based upon such an assessment, engineering design criteria for facilities and operations shall be developed for use in the selection of equipment, shielding, engineering controls, and protective clothing for personnel.

C4.2.1. The risk assessment shall include:

C4.2.1.1. Initiation sensitivity.

C4.2.1.2. Quantity of materials.

C4.2.1.3. Heat output.

C4.2.1.4. Rate of burn.

C4.2.1.5. Potential ignition and initiation sources.

C4.2.1.6. Protection capabilities of shields, various types of clothing, and fire protection systems.

C4.2.1.7. Personnel exposure.

C4.2.2. New or modified facilities, located within the IBD arc of any PES, that will include glass panels and will contain personnel, shall have a glass breakage personnel hazards risk assessment conducted.

C4.3. PERMISSIBLE EXPOSURES

C4.3.1. Accidental Ignition or Initiation of Explosives.

C4.3.1.1. When a risk assessment indicates that there is an unacceptable risk from an accidental explosion or a flash fire, personnel shall be provided protection from blast, fragments, and thermal effects, to include respiratory and circulatory hazards.

C4.3.1.2. When required, personnel protection must limit incident blast overpressure to 2.3 psi [15.9 kPa], fragments to energies of less than 58 ft-lb [79 joules], and thermal fluxes to 0.3 calories per square centimeter per second [12.56 kilowatts per square meter].

C4.3.1.3. K24 [9.52] distance provides the required level of protection for blast and thermal effects only.

C4.3.1.4. Shields that comply with Military Standard (MIL-STD)-398 (Reference (h)) provide acceptable protection for blast, thermal and fragment effects.

C4.3.2. Intentional Ignition or Initiation of AE. At operations (e.g., function, proof, lot acceptance testing) where intentional ignition or initiation of AE are conducted and where shielding is required, as determined on a case-by-case basis by the DoD Component concerned, personnel protection shall:

C4.3.2.1. Meet the requirements of subparagraph C4.3.1.2.

C4.3.2.2. Limit overpressure levels in personnel-occupied areas to satisfy MIL-STD-1474D (Reference (i)).

C4.3.2.3. Contain or defeat all fragments.

C4.3.2.4. Limit thermal flux to: “Q” (calories/square centimeter/second) = $0.62t^{-0.7423}$ where “t” is the time in seconds that a person is exposed to the radiant heat. (Shields that comply with Reference (h) provide acceptable protection.)

C4.4. PROTECTIVE MEASURES

Personnel protection may be achieved by:

C4.4.1. Eliminating or establishing positive control of ignition and initiation stimuli.

C4.4.2. Using sufficient distance or barricades to protect from blast or fragments.

C4.4.3. Using fire detection and extinguishing systems (e.g., infra-red (IR) actuated deluge system) in those areas where exposed, thermally-energetic materials that have a high probability of ignition and a large thermal output are handled. Such systems shall maximize the speed of detection, have adequate capacity to extinguish potential flash fires in their incipient state, and maximize the speed of the application of the extinguishing agent.

C4.4.4. Using thermal shielding between the thermal source and personnel in AE operational areas, where it is essential for personnel to be present and the risk assessment indicates that an in-process thermal hazard exists. Any shielding used shall comply with Reference (h). When shielding is either not possible or inadequate, to include a failure to protect exposed personnel's respiratory and circulatory systems, augmentation with improved facility engineering design and personnel protective clothing and equipment may be necessary.

C4.4.5. Using thermal protective clothing that is capable of limiting bodily injury to first degree burns (0.3 calories per square centimeter per second [$12.56 \text{ kilowatts/m}^2$]) with personnel taking turning-evasive action, when the maximum quantity of combustible material used in the operation is ignited.

C4.4.6. Using protective clothing capable of providing respiratory protection from the inhalation of hot vapors or any toxicological effects, when the risk assessment indicates adverse effects would be encountered from the inhalation of combustion products.

C4.4.7. Minimizing the number and size of glass panels in an ES and, if possible, orienting the ES to minimize blast loads on glass panels, when a risk assessment (see section C4.2.) indicates that a glass hazard is present.

C4.4.7.1. When use of window panels is determined to be necessary and a risk assessment determines that there will be an associated glass hazard, blast-resistant windows of sufficient strength, as determined by an engineering analysis, shall be used for:

C4.4.7.1.1. Existing ES, upon major modification or modified operations.

C4.4.7.1.2. New construction. (The use of glass panels in new construction should be avoided.)

C4.4.7.2. The framing and sash of such panels shall be of sufficient strength to retain the panel in the structure for the expected blast loads from an explosion at any PES.

C4.5. Quantitative Risk Assessment (QRA)

A QRA tool for risk management of explosives storage and operating scenarios, and the associated exposures (related or unrelated personnel and facilities) to those scenarios, can provide for a comparison of risks prior to acceptance of risks associated with the selected scenarios. (See Chapter 17 for additional information on QRA.)